

# TDOT Forecasting Office Update

Jaehoon Kim | Forecasting Office Supervisor | October 26, 2017

## Updates

Data Management Section







## Tennessee Statewide Model Capabilities and Potential for MPO Model Development

Kwabena Aboagye | Planning Manager; Jaehoon Kim | Forecasting Office Supervisor; Jeff Ultee and Tahmina Khan | Planning Specialists | October 26, 2017

## Outline (1/2)

- Background
  - History
  - Statewide Model Acronym
  - Status
- Model Structure
  - Overall Model
  - Traffic Analysis Zones
  - Network
  - Short Distance Model
  - Long Distance Model
  - Freight Model
  - Assignment



## Outline (2/2)

- Data
  - Input Data
  - Skimming Zone Systems
  - Model Estimation
  - Pivoting
  - Validation and Calibration
  - TDOT Data Availability
- TSM Applications
  - TSM Possibilities and Limitations
  - General Applications
  - TDOT Applications
- Potential for MPO Use
  - EE trips, Freight Movement, Travel time, etc.
- GOING FORWARD Survey and Q&A



# Background



## History

- Version 1 2003/2004. Coarse (Did not include all HWYs)
- Version 2 New model
  - Phase 1 input dataset focus; started 2012.
  - Phase 2 Interim model to support LRP
    - Simple three-step trip-based model
    - Well validated but lacked sensitivity
- Version 3 / Phase 3
  - First delivered September 2016
  - Advanced functionality and sensitivity
  - Covers entire country
  - Advanced trip based model



## Statewide Model Name

- Historically, statewide model has had the acronym SWM
- Current model was delivered to TDOT as Tennessee Statewide Travel Model (TSTM) by consultant
- TSM (Tennessee Statewide Model) has also been used in the past to describe the Statewide model
- Going forward, The current Statewide model will be known as the Tennessee Statewide Model – **TSM**



## Status

- We have been going through model to find/fix errors, working with consultant as needed
  - Improve reasonability of input data
  - Checking loaded network (raw and post-processed)
  - Update network with recent or upcoming projects
- Other challenges that remain
  - Model run time, disk space, and running errors
  - Creating automated scripts to summarize model output





# Model Structure

## Overall Model





## Traffic Analysis Zones (TAZs)

- MPO areas aggregated MPO model zones
  - Including zones outside TN for bistate MPOs
- Rural areas travelshed principles
  - FHWA
  - Keeps corridors from being dividing lines when they are centers
  - National Atlas (railroads, water bodies); National Hydrology Dataset (NHD) (topological); National Elevation Dataset (NED); State Parks; National Park Boundaries; Forest Land Unit and Wilderness Management Areas
- Outside of TN
  - Counties, county combinations, or entire states







## Network

- Inside TN
  - All NHS routes in FAF/NHPN network
  - All arterials and interstates
  - Collectors and local roads
- Outside of TN
  - FAF/NHPN simply used
  - Additional major roadways facilitating movement across TN border





## Short Distance Model

- For trips < 50 miles
- Similar to MPO trip-based model
- "Destination Choice" is
  advanced trip distribution
  - Replaces gravity model
- Mode choice comes *before* destination choice
  - Transit/walk/bike filtered out
- NHB trips estimated after HB trips





## Long Distance Model

- Base year synthetic population scaled up for future year
- rJourney
  - National long distance model
  - Tour-based
  - Account for different purposes (leisure/vacation, employer's business, etc.)
  - Modes: highway, intercity bus, intercity rail, commercial air





## Freight Model

- Two sub-models
  - Commodity flow
  - Single-unit (SU) trucks
- Commodity flow
  - multimodal freight
  - Truck, rail, water, air, truck rail intermodal
  - Test new intermodal facilities, rail lines, & ports
- Single-unit (SU) trucks
  - For other commercial vehicles
  - Simple, quick-response trip based model





## Assignment

- Tri-conjugate Frank-Wolfe (TCFW) algorithm
- Multi-class user equilibrium
- TCFW has proven the most efficient algorithm for tight model convergence on large networks
- Relative gap of 0.0001





## Data

## Input Data

- Socioeconomic (SE) data
  - Base year
    - Demographic data 2010 Decennial Census and ACS
    - Employment InfoGroup, LEHD, BEA County Business Patterns (CBP), MPO total employment estimates
  - Future year
    - UT Center for Business and Economic Research (CBER)
    - Woods & Poole
    - Additional steps and input from MPOs/stakeholders
- Network
  - TRIMS based/HPMS
  - All-Streets
  - National Highway Planning Network (NHPN) from FHWA
  - FAF3



## Skimming Zone Systems

- Short-distance trips main zone system is used
- Long-distance trips NUMA
  - NUMA National User Model Area from FHWA
- Freight Transearch
  - (FAF3 also used in development and testing of freight models but excluded from final model.)



## Model Estimation

- Combined HH Travel Survey
  - Knoxville TPO
  - Nashville MPO
  - National HH Travel Survey
    - TN Add-on Sample
- National Transit Database (NTD)
- Transearch



## Pivoting

- Big Data sources:
  - AirSage cell phone data
  - ATRI truck GPS data
- Data converted to Origin-Destination matrix trips
- Modeled volumes pivoted to data-derived volumes.



## Validation and Calibration

- Short distance model
  - Combined HHTS
  - 2014 ACS
  - LEHD
  - National Transit Database (NTD)
  - Traffic counts (TRIMS)
- Long distance AirSage
- Freight Transearch
- Traffic volumes TRIMS
- Free-flow speeds NPMRDS



## TDOT Data Availability

- AirSage, Transearch, WP can be shared with MPOs, universities in TN for TDOT research purposes
- InfoGroup MPOs
- ATRI cannot currently share
- HERE can only share processed data
  - We are open to discuss further needs for processing data





# TSM Applications

## TSM Possibilities and Limitations

#### Strength

- Advanced Trip Based Model
  - Short Distance
- Long Distance
- Freight
- Data Driven Pivoting
- Provide broad overview of urban & rural areas
- Includes post-processor

#### Weakness

- Calibration and Validation
- NOT Flexible to Customize

Opportunities

- Possible for various Applications
- Possible to provide Information
- Possible to support MPO model development

#### Threats

TSM

- Still Need to Fix Bugs
- Still Need to Update Model Input Data
- rJourney Model Error
- Running Time
- Post-processed volumes not always intuitive



## General Applications

- Project Prioritization
- Revenue Forecasting
- Corridor Study
- Network Resilience Analysis
- Assessing Changes in Performance Measures
- And more!



## TDOT Applications - Case 1

- Grant Application
  - INFRA Grant Application for I-69 Project
  - Used to estimate various input data for Benefit Cost Analysis
    - Vehicle-Miles Traveled
    - Vehicle-Hours Traveled
    - Vehicle-Hours Delayed
    - Traffic Flows
  - Congestion Impact Analysis
  - Forecasting of Crash Frequency



## TDOT Applications - Case 2

- 3-Year Work Program Profiling
  - Current & Future Traffic Count Forecasting
  - Volume / Capacity Ratio
  - Truck Volume

#### SR - 104 Gibson and Dyer Counties, 104123.06 Purpose and Need: The purpose of this project is to improve the safety and roadway deficiencies associated with the existing SR-104 to west of SR-188 that would

clencies associated with the existing SR-104 to west of SR-188 that would minimize impacts to the human and natural environment and bring tarffic conditions to meet current TDOT design standards. The project is needed to develop a transportation solution that is compatible with existing and planned land use activities adjacent to or nearby the new roadway. Is able to meet present and future traffic demands, provides local and regional motorists with improved connections to other major highways including SR-54, SR-5, and US Route 45W, improves regional mobility and highway safety, and reduces traffic congestion through Trenton.

#### Socio-Economic Data

Traffic Data

Table 1: Gibson County Socio-economic Data												
	2010	2016	2021	2050								
Total Population	49,726	49,705	50,334	50,061								
Median Age	39.95	40.12	40.4	40.5								
Number of Households	19,699	20,620	21,013	20,224								
Mean Household Size	2.47	2.36	2.35	2.42								
Median Household Income	35,923	42,408	48,308	76,126								
Table 2: Dyer County Socio-economic Data												
	2010	2016	2021	2050								
Total Population	38,321	38,209	38,935	40,150								
Median Age	39.34	39.97	40.24	39.92								
Number of Households	15.185	15.837	16.213	16.022								
Mean Household Size	2.49	2.38	2.37	2.47								



Table 3: Traffic Data for State Route 104 (Rural Minor Arterial & Urban/Rural Principal Arterial)												
Measure	Source	Segment 1 (2 Lane Undivided Urban SR)	Segment 2 (2 Lane Undivided Rural SR)	Segment 3 (2 Lane Undivided Rural SR)	Segment 4 (2 Lane Undivided Rural SR)	Segment 5 (4 Lane Divided Rural SR)	Segment 6 (4 Lane Divided Rural SR)	Segment 7 (2 Lane Undivided Rural SR)	Segment 8 (2 Lane Undivide Rural SR)			
AADT	Original Base Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			
	Original Forecasted Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			
	Statewide Model (2010) Version 3	3,020	2,610	1,020	1,310	1,690	1,820	1,560	3,240			
	TRIMS (2015) - Existing/Current Count	3,230	2,460	1,270	1,300	1,550	1,740	2,100	2,910			
	Statewide Model (2040) Version 3 Forecasted	3,527	3,118	1,316	1,646	1,963	2,109	1,707	3,462			
Truck Volume	Statewide Model (2010) Version 3 Truck Flow	105	60	75	75	59	27	39	39			
	TRIMS (2015) - Existing/Current Count	129	123	51	52	109	104	105	87			
	Statewide Model (2040) Version 3 Forecasted Truck Flow	162	109	124	124	105	44	54	49			
Volume/Capacity Ratio	Statewide Model (2010) Version 3	0.10	0.09	0.03	0.04	0.05	0.02	0.05	0.12			
	Statewide Model (2040) Version 3 Forecasted	0.12	0.1	0.04	0.05	0.06	0.02	0.05	0.13			
Crash Rate	Section Level (2012 - 2014)	0.40	0.24	0.33	0.52	0.35	0.16	0.86	0.47			
	Statewide Section Average	2.556	1.709		0.768		1.709					
	Intersection Level (2012 - 2014)	0.00	0.24	0.83	0.46	0.39	0.66	2.01	2.06			
	Statewide Intersection Average	0.408	0.482		0.203		0.482					



## TDOT Applications - Case 3

#### Rural Regional Transportation Plan

- TSM can be used for analyses of rural areas
- Current & Future Traffic Volume
- Volume / Capacity Ratio





## Potential MPO Use (1/3)

- Can provide estimation of external station data for MPO model development
  - Strength: Various data sources are used
  - Weakness: Need more calibration process
  - Opportunity: Small area MPO model
- Can provide traffic forecasts
  - Opportunity: feedback and integrating statewide model with urban model



## Potential MPO Use (2/3)

- Can provide travel time and speed information on more functional classes of roadway
  - NPMRDS vs TSM





## Potential MPO Use (3/3)

- Freight volume / Truck volume
  - Strength: Transearch Data and ATRI data were used
  - Opportunity: provide various freight information
    - Regional long distance freight/truck flows
    - External-External Commodity/Truck Trips
    - County level long distance commodity production/consumption
  - Weakness
    - Very aggregated level





# GOING FORWARD

## Survey

- Goal To know the challenges MPOs face and how TDOT can better assist MPOs in developing MPO Travel Demand Model
- Survey Respondents All 11 MPOs will be required to complete a survey
- Email Survey FO will send each coordinator the survey questionnaire



## Survey - Questionnaire (1/2)

- General Information
  - Confidentiality

### Data Sources

- Demographic Data
- Socioeconomic Data
- Network Data
- Commercial Data (Purchased)
- Commercial Data (Needed, but NOT purchased)
- Model Development Challenges
- Expectations to TDOT
  - TDOT Database
  - TDOT Model Approval Process
  - Satisfaction with TDOT Collaboration



## Survey - Questionnaire (2/2)

- Moving Forward
  - Future Data Purchase (HERE or other commercial data)
  - Small size MPO Household Travel Survey
  - Opinions on the Standardized Travel Demand Model
  - Preferred the Analytic Software
  - Training









## Contact Information

Jaehoon Kim, PhD Forecasting Office Supervisor Long Range Planning Division Jaehoon.Kim@tn.gov (615) 837-5464

Jeff Ultee, MCRP, MS Planning Specialist Forecasting Office Long Range Planning Division Jeffrey.Ultee@tn.gov (615) 253-8816 Majid Khalilikhah, PhD Planning Specialist Forecasting Office Long Range Planning Division <u>Majid.Khalilikhah@tn.gov</u> (615) 253-2738

Tahmina Khan, PhD Planning Specialist Forecasting Office Long Range Planning Division <u>Tahmina.Khan@tn.gov</u> (615) 253-2737

